California’s Effort to Improve Almond Orchard Crop Coefficients


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Almonds are a major agricultural commodity in California and optimal irrigation management is important for production, protecting the environment, and long term water resources planning. While evapotranspiration (ET) estimates are widely used for water resource planning, it is used less for “realtime” irrigation management for several reasons. One problem is the lack of confidence in the crop coefficient (Kc) values that are used with reference ET (ETo) to estimate well-watered crop ET (ETc). This is especially true for orchard crops. Until recently, the Kc values used to estimate the ETc of most orchard crops in California were derived using measurements of applied water, runoff, and soil water content depletion with the assumption that the trees were transpiring at a rate that was not restricted by water availability. For decades, a typical midseason Kc value used for clean-cultivated almond orchards was 0.90. Recently, a study was conducted by the University of California and the California Department of Water Resources to improve the Kc estimates for almond orchards; helping growers improve their on-farm water management for better production and less adverse impacts on the environment. Field experiments were conducted in four locations (Butte, Fresno, Kern, and Tehama Counties) spanning 1000 km north to south within the Central Valley of California over somewhat different climates. California Irrigation Management Information System (CIMIS) weather stations were used with the ASCE-EWRI standardized reference evapotranspiration equation for short canopies to determine ETo. Latent heat flux (LE), in all four orchards, was estimated using the residual of the energy balance equation: LE=Rn-G-H from measured net radiation (Rn), ground heat flux (G), and sensible heat flux (H) using surface renewal and eddy covariance measurements. The LE was divided by the latent heat of vaporization (L) to determine ETc. In three years of measurements in Kern County, the data showed an increase in Kc values from about 0.90 in early April to about 1.15 at the end of August. In Butte County during 2009, the Kc values increased rapidly from about 0.90 to 1.20 from early April to early June and stayed near 1.20 until mid-September. In Tehama County, the Kc values started near 1.00 in April and then dropped to about 0.90 during early May. The Kc values then increased to just below 1.20 at the beginning of July and stay just under 1.20 until late August when they started to decline. In Fresno County, the Kc values fluctuated between about 1.00 and 1.20 during most of mid-season. In general, these midseason Kc values were more than 25% higher than the 0.90 value that was used for decades; confirming that more realistic Kc values were needed. In this paper, we will present the results of these studies and we will discuss the factors that explain the observed differences.

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